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April 10, 2019

Jeffrey Fowlow, Task Monitor
United States Environmental Protection Agency
1200 Sixth Avenue, Mail Stop ECL-133
Seattle, Washington 98101

Re: *Tacoma Aluminum Phosphide Response Trip Report*
Contract Number: EP-S7-13-07
Task Order Number: TO-520-008

Dear Mr. Fowlow:

Enclosed please find the Final Trip Report for the Tacoma Aluminum Phosphide Response site, which is located in Tacoma, Washington. If you have any questions regarding this submittal, please call me at (206) 624-9537.

Sincerely,
ECOLOGY AND ENVIRONMENT, INC.

David Burford
START-IV Team Leader

cc: Bonnie Criss, Project Manager, E & E, Seattle, Washington

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FINAL TRIP REPORT

Tacoma Aluminum Phosphide Response Site

Tacoma, WA

TASK ORDER: 0520-008



Prepared for

U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by

Ecology and Environment, Inc.
720 Third Avenue, Suite 1700
Seattle, Washington 98104

April 2019

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1. PLACE VISITED

Site Name:	Tacoma Aluminum Phosphide Response
Property Owner Name:	EcoLab Inc. (EcoLab)
Location:	401 East Alexander Ave., Lot #1
Latitude, Longitude:	47.295499, -122.4333087
Date(s) of Trip:	March 20, 2019

2. PURPOSE

The United States Environmental Protection Agency (EPA) has tasked Ecology and Environment, Inc., under Superfund Technical Assessment and Response Team (START) contract number EP-S7-13-07, Task Order 520-008 to support EPA during an emergency response to a chemical release from an aluminum phosphide fire in Tacoma, Washington (Figure 1). The purpose of the Tacoma Aluminum Phosphide Response was to:

- Conduct perimeter air monitoring;
- Monitor cleanup activities; and
- Provide photo documentation.

START was tasked to provide technical support and document site conditions and activities through logbook entries and photographs. Following the document are attachments associated with the tasks outlined above:

- Photographic Documentation (Attachment A)
- PRP (Potentially Responsible Party) Air Monitoring Log (Attachment B)

3. PERSONS INVOLVED

Agency/Company	Contact Persons/ Position	Phone Number
EPA	Jeffrey Fowlow, Federal On-Scene Coordinator	(206) 553-2751
Washington Department of Ecology (Ecology)	Ron Holcomb, State On-Scene Coordinator	(360) 407-6373
	Miriam Duerr, Spill Responder	(360) 407-6846
START	Bonnie Criss, Project Manager	(206) 624-9537
	Tom Vroman, Site Safety Officer	
	Seth Wing, Field Responder	
	Erin Cafferty, Field Responder	
EcoLab Inc. (PRP)	Michael Carette-Meyers, General Manager	(253) 306-6828
National Response Corporation (NRC)	Roman Geigle, Response Manager	(503) 522-2473

4. BACKGROUND AND SITE DESCRIPTION

At 1709 on March 19, 2019, the Tacoma Fire Department responded to a fire located in the Port of Tacoma at an EcoLab chemical tote facility (hereafter referred to as the facility). The source of the fire was two 55-gallon drums containing approximately 400,000 pellets of partially spent Weevil-Cide fumigant. The fumigant pellets are made up of 60 percent aluminum phosphide in a proprietary clay based mixture, meant to slowly react and off-gas phosphine gas (PH₃). The fumigant had previously been removed prematurely from a grain transport vessel and bulked in the drums with the intent to react safely until the material had stabilized. However, the

containment was inappropriate for the quantity of the fumigant and resulted in a more aggressive reaction, causing a small fire and white smoke plume.

At 2050 hours on March 20, the Tacoma Fire Department, their responding hazmat team, and Ecology, at the advice of the manufacturer, spread the solid material onto the asphalt to allow the reaction to proceed in a controlled manner. The Tacoma Fire Department left the site at 2245 hours.

After the departure of the Tacoma Fire Department, the PRP prematurely packaged the spent material in a solution of water and detergent which reignited at 2355 hours and required the Tacoma Fire Department to redeploy to the scene. At this time, the hazmat team's air monitors were still indicating high levels of PH_3 as well as hydrogen cyanide gas (HCN) that warranted the evacuation of the facility and a shelter-in-place being issued for personnel at the nearby Trident Seafood Facility. Ecology requested EPA's assistance with air monitoring of the chemical release and the surrounding area.

5. FIELD ACTIVITIES

EPA activities at the site can be categorized into the following functional areas:

- Mobilization, site set-up, and initial reconnaissance;
- Establishment of site screening approach and action levels;
- Roving air monitoring;
- PRP air monitoring;
- Chemical reaction monitoring; and
- Remobilization, mitigation actions, and final demobilization.

5.1 Mobilization, Site Set-up, and Initial Reconnaissance

EPA and START arrived on site at 0350 hours on March 20 conduct community air monitoring. EPA entered into Unified Command (UC) with Ecology, the Tacoma Fire Department, and the PRP. After evaluating the site, the community, and the behavior of the PH_3 being released, the UC decided that perimeter air monitoring, rather than community air monitoring, would be a sufficient response action to appropriately characterize site contaminants and concentrations.

START deployed four stationary AreaRAE Pro air monitors outfitted with a photoionization detector (PID), oxygen (O_2), carbon monoxide (CO), hydrogen sulfide (H_2S) and lower explosive limit (LEL) sensors. The AreaRAE Pros were positioned at four locations (MS01, MS02, MS03, and MS04; Figure 2) around the southeast edge of the facility courtyard covering the local businesses. Two Drager Pac 7000 hydrogen cyanide sensors were additionally placed at locations MS02 and MS03 to be used as a qualitative check for PH_3 in the event that there were detections on the PID and LEL sensors (for further discussion on the use of HCN sensors, see Section 5.2).

5.2 Establishment of Site Screening Approach and Action Levels

Aluminum phosphide reacts with water, including moisture in the air, to produce PH_3 and aluminum oxide. While the aluminum oxide product itself presents no hazard, PH_3 is both toxic at relatively low concentrations and can be explosive when it exceeds an atmospheric concentration of 1.8 percent PH_3 . Due to the physical properties of PH_3 , it can be detected using

a PID and a Lower Explosive Limit (LEL) sensor utilizing a correction factor. PH₃-specific sensors can also be utilized as well as HCN sensors, which have a cross-sensitivity with PH₃, although the gas is not accurately quantifiable with HCN sensors. The responding Tacoma Hazmat Team reported the presence of HCN as a result of this cross-sensitivity and START utilized this in their stationary air monitoring activities.

During the initial response, START utilized the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) of 0.3 parts per million (ppm) for PH₃ as the turnback level for responders. For the remobilization of the response, the responder turnback level was lowered to 0.15 ppm following the American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLV).

5.3 Roving Air Monitoring

A roving monitoring team was deployed utilizing a Drager PAC III Phosphine gas detector for primary PH₃ measurements and a MultiRAE Pro outfitted with a PID, LEL, O₂, CO, H₂S, and an additional HCN sensor. The team moved around the perimeter of the building on accessible roads collecting regular measurements of the PH₃, HCN, and volatile organic compound (VOC) concentrations and entering results using a data collection system that fed into a geospatial viewer. The roving team continued to collect data until 0900 hours.

Throughout the morning, there was a predominant wind to the west-northwest through the area affected by the structures present on site, resulting in a wind channel. The highest concentrations of PH₃ were found along this wind channel, and ranged from 0 ppm to 0.15 ppm, with an average of 0.09 ppm. There were two instances where the wind direction shifted temporarily causing concentrations of 0.33 ppm and 0.24 ppm to the south and east side of the site, respectively. All other perimeter monitoring locations were non-detect for PH₃.

5.4 PRP Air Monitoring

At 0600 hours, NRC (the PRP's emergency response contractor) arrived on site to support the monitoring and cleanup of the ongoing reaction. According to the manufacturer and documented by NRC in their after action incident briefing, standard operation with aluminum phosphide experiencing an ongoing reaction is to allow the reaction to proceed until activity halts and then agitate it to reinitiate the reaction until all the material is consumed (NRC 2019). However, due to the instability of the reaction, the location, and the quantity of the aluminum phosphide, NRC recommended allowing the aluminum phosphide to react slowly undisturbed for a duration of 24 hours rather than manually try to speed the reaction for public safety. This would allow the slow production of PH₃ that would dissipate to safe concentrations and not require actions to be taken that would affect local business operations. The UC agreed on this proposed action.

Ecology and EPA agreed that NRC would take over START's perimeter air monitoring activities for the duration of the day while continuing to monitor the reaction. The UC devised a monitoring plan for NRC to follow. Six monitoring locations were established (ML01, ML02, ML03, ML04, ML05, and ML06) where readings with an MSA Altair PH₃ Pro Detector provided by the PRP would be collected by NRC every half hour until the material had been completely consumed and was no longer producing PH₃.

EPA and Ecology established action levels for the PRP and NRC to notify the UC based on the NIOSH REL. If concentrations of PH_3 exceeded 0.3 ppm for a period of 5 minutes, or if a peak concentration of greater than 5 ppm (10 percent of the Immediately Dangerous to Life or Health (IDLH)) value was detected at locations outside the courtyard perimeter (ML03, ML04, ML05, or ML06), notifications to UC would occur. Additionally, if a concentration of 0.5 ppm PH_3 for 15 minutes was detected within the courtyard boundaries (ML01 and ML02), then UC would be notified.

NRC's monitoring results are provided in Attachment B. With the exception of one point (MS04 reading 0.15 ppm at 0800 hours), all other points were reported to have no PH_3 detection.

5.5 Chemical Reaction Monitoring

Between 0920 and 1100 hours, three violent chemical reactions occurred. The explosions produced a large noise and a vapor clouds likely containing water and PH_3 that were released into the atmosphere. Each subsequent reaction was significantly less intense than the previous. Air monitoring by NRC continued throughout the explosions.

5.6 Remobilization, Mitigation Actions, and Final Demobilization

Once most of the local business activity in the vicinity had ceased operations later in the afternoon, and visual and thermal indications of an active reaction had stopped, the UC decided to agitate the remaining material early to reinitiate the reaction and assure that the material was fully consumed.

START remobilized to the site on the evening of March 20 to conduct confirmation air monitoring for the duration of the reaction activities. Similar to the morning activities, START placed four AreaRAE Pros at locations MS03, MS05, MS06, and MS07, this time targeting locations along the wind channel. Roving monitoring was also conducted at the established monitoring locations (ML01, ML02, ML03, ML04, ML05, and ML06) using a Drager Pac III PH_3 detector and a MultiRAE Pro with a HCN sensor. The roving team collected data for PH_3 , HCN, and VOC concentrations and entered the data into the data collection system. PH_3 was only detected at locations ML02 and MS07, ranging from 0.0 ppm to 0.12 ppm.

NRC dressed out in level B Personal Protective Equipment (PPE), utilizing Self-Contained Breathing Apparatuses and fire retardant clothing along with a PH_3 detector for safety monitoring. NRC entered the hot zone at 2000 hours using shovels and rakes to remove the top layer of each container. If this action did not yield any visual indications of a further reaction, they would then manually agitate the contents of the containers. Throughout the agitation activities, a maximum PH_3 concentration of 1.83 ppm was detected directly down wind of the activities by NRC but quickly dissipated to concentrations below action levels. By 2020 hours, NRC had exited the area. Only one of the containers showed any evidence of furthered reaction. At 2100 hours, UC determined that the emergency phase of the response had concluded and EPA, Ecology, and START demobilized from the site. The containers were left overnight as an additional precaution with NRC conducting regular air monitoring until the following morning.

6. WASTE AND DISPOSAL

On March 21, NRC returned to the site and packaged the reacted aluminum phosphide material into U.S. Department of Transportation (DOT)-approved 55-gallon drums. NRC entered in Level C PPE and used a vacuum to transfer that material into the drums. The maximum PH_3 level detected during this process was reported to be 0.02 ppm. The lids to the containers were placed but not secured to avoid any further gas build-up and the drums were left on site for the PRP to dispose.

7. SUMMARY AND CONCLUSIONS

On March 19, 2019, two 55-gallon drums containing approximately 400,000 pellets of aluminum phosphide fumigant were removed prior to fully reacting from a vessel and bulked together by the PRP causing a violent chemical reaction that resulted in a fire and the production of PH_3 . The Tacoma Fire Department and Ecology were deployed and spread the contents of the containers out to react in the facility courtyard. After the fire department demobilized, the PRP repackaged the material prematurely into drums and covered them with a water and soap mixture. The material again began to react violently requiring the return of the Tacoma Fire Department.

The aluminum phosphide continued to react with the water, producing a large quantity of PH_3 that threatened the local community and required the evacuation of the facility and a shelter-in-place of another nearby facility. Ecology requested EPA support with air monitoring activities. EPA and START arrived on site early on March 20, and began conducting perimeter air monitoring until a PRP contractor could be arranged. NRC, an emergency response contractor for the PRP, arrived on site and assumed perimeter air monitoring activities.

On March 20, although PH_3 was detected, no action level exceedances occurred that required any further response actions. On the evening of March 20, after the reaction appeared to be complete, NRC agitated the material with a shovel to attempt to reinitialize any further reaction. One container showed evidence of only minor reaction activity and UC concluded the emergency response. The material was left overnight while NRC continued monitoring for both PH_3 in the air and any further reactions in the containers. On March 21, NRC packaged the reacted material into DOT-approved 55-gallon drums and left them on site for disposal by the PRP.

8. REFERENCES

National Response Corporation (NRC), March 27, 2019, *Incident Briefing: Phosphine Gas Reaction*.

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Date: 4/8/2019



FIGURE 2
AIR MONITORING LOCATIONS
TACOMA ALUMINUM PHOSPHIDE RESPONSE SITE
 Tacoma, Washington

Date: 4/8/2019

ATTACHMENT A
Photographic Documentation

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Tacoma Aluminum Phosphide Response

Tacoma, Washington

TO Number: TO-0520-008
Photographed by: Bonnie Criss (BC), Seth Wing (SW), Tom Vroman (TV)



Photo 1 The Ecolab courtyard with the containers of aluminum phosphide reacting in the background.

Direction: East

Date: 3/20/19

Time: 8:24

Taken by: SW



Photo 2 Boomed run-off from Tacoma Fire Department's efforts to halt the fire during the initial response.

Direction: North

Date: 3/20/19

Time: 8:24

Taken by: SW



Photo 3 Gas and vapors released following one of the violent chemical reactions.

Direction: North

Date: 3/20/19

Time: 9:28

Taken by: BC

Tacoma Aluminum Phosphide Response

Tacoma, Washington



Photo 4 The gas and vapors migration off-site following a violent chemical reaction.

Direction: Northeast Date: 3/20/19 Time: 9:23 Taken by: TV

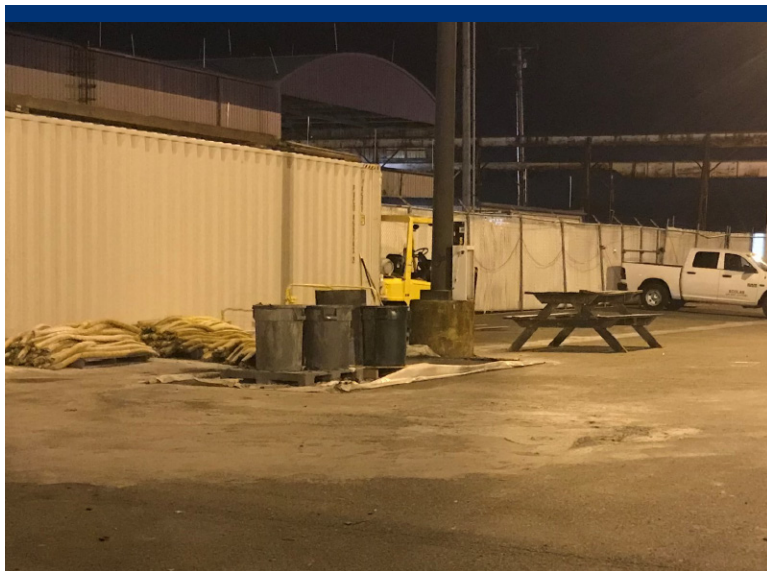


Photo 6 Southernmost grouping of containers holding the reacting aluminum phosphide material.

Direction: West Date: 3/20/19 Time: 20:30 Taken by: BC

TO Number: TO-0520-008
Photographed by: Bonnie Criss (BC), Seth Wing (SW), Tom Vroman (TV)



Photo 5 NRC conducting the agitation activities with oversight from Unified Command.

Direction: West Date: 3/20/19 Time: 20:03 Taken by: BC



Photo 7 Northernmost grouping of 55-gallon drums containing the reacting aluminum phosphide.

Direction: Northwest Date: 3/20/19 Time: 20:30 Taken by: BC

Tacoma Aluminum Phosphide Response

Tacoma, Washington

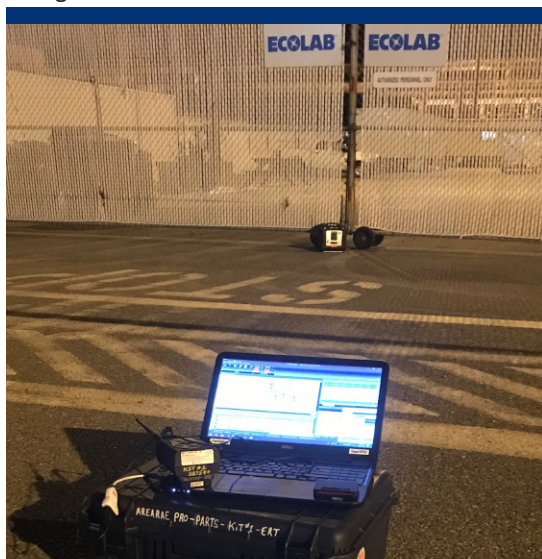


Photo 8 ProRAE Guardian communicating and logging data remotely from the stationary AreaRAE monitoring locations.

Direction: Northwest Date: 3/20/19 Time: 20:35 Taken by: BC

TO Number: TO-0520-008
 Photographed by: Bonnie Criss (BC), Seth Wing (SW), Tom Vroman (TV)

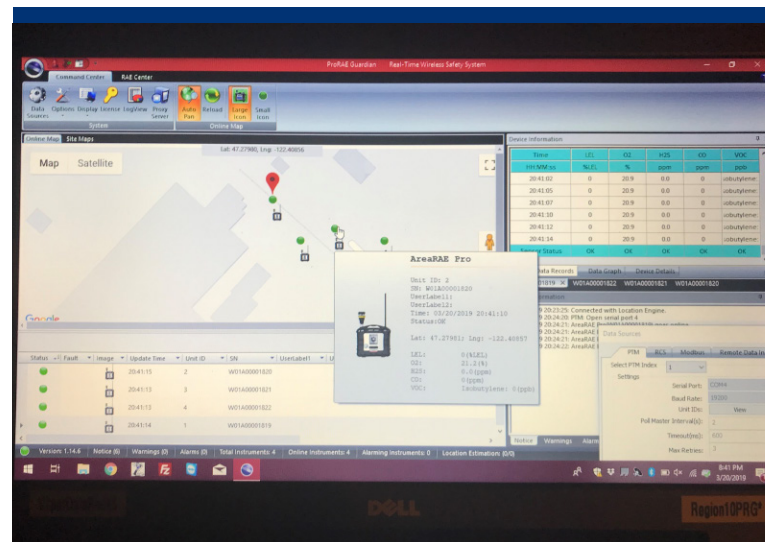


Photo 9 ProRAE Guardian displaying the stationary monitoring location and ongoing data collection from the AreaRAE monitors.

Direction: Down Date: 3/20/19 Time: 20:41 Taken by: BC

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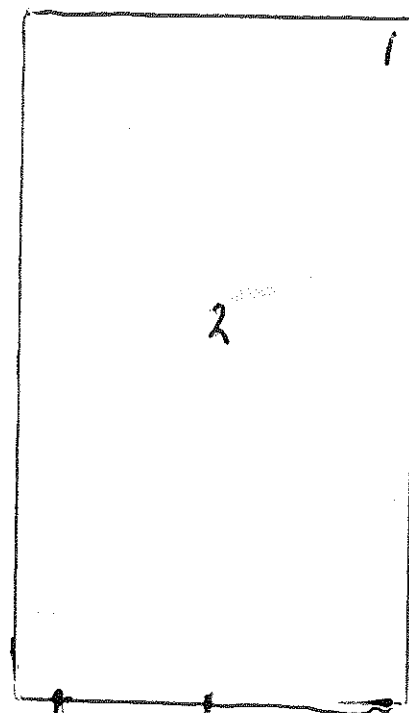
Attachment B
PRP Air Monitoring Log

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Monitoring plan readings 3.20.2019

Phosphine readings per EPA and Washington state dept of ecology

8:00 am	1	0	2	0	3	0	4	0.15	5	0	6	0	3
8:30am	1	0	2	0	3	0	4	0	5	0	6	0	
9:00am	1	0	2	0	3	0	4	0	5	0	6	0	
9:30am	1	0	2	0	3	0	4	0	5	0	6	0	
10:00am	1	0	2	0	3	0	4	0	5	0	6	0	
10:30am	1	0	2	0	3	0	4	0	5	0	6	0	
11:00am	1	0	2	0	3	0	4	0	5	0	6	0	
11:30am	1	0	2	0	3	0	4	0	5	0	6	0	
12:00pm	1	0	2	0	3	0	4	0	5	0	6	0	
12:30pm	1	0	2	0	3	0	4	0	5	0	6	0	
13:00	1	0	2	0	3	0	4	0	5	0	6	0	
13:30	1	0	2	0	3	0	4	0	5	0	6	0	4
14:00	1	0	2	0	3	0	4	0	5	0	6	0	
14:30	1	0	2	0	3	0	4	0	5	0	6	0	
15:00	1	0	2	0	3	0	4	0	5	0	6	0	
15:30	1	0	2	0	3	0	4	0	5	0	6	0	
16:00	1	0	2	0	3	0	4	0	5	0	6	0	
16:30	1	0	2	0	3	0	4	0	5	0	6	0	



front
gate

5

6

Monitoring readings 3.20.2019 continued

17:00	1	2	3	4	5	6
17:30	1	2	3	4	5	6
18:00	1	2	3	4	5	6
18:30	1	2	3	4	5	6
19:00	1	2	3	4	5	6
19:30	1	2	3	4	5	6
20:00	1	2	3	4	5	6
20:30	1	2	3	4	5	6
21:00	1	2	3	4	5	6
21:30	1	2	3	4	5	6
22:00	1	2	3	4	5	6
22:30	1	2	3	4	5	6
23:00	1	2	3	4	5	6
23:30	1	2	3	4	5	6
00:00 3.21	1	2	3	4	5	6
00:30	1	2	3	4	5	6
01:00	1	2	3	4	5	6
01:30	1	2	3	4	5	6